

REMARKS

After entry of this Amendment and Response, claims 1–4, 6–7, 10–15, 18–19, 21–24, 26–31, 33–41, 43–53, 55, 57–68, 70–74, 76, and 78–80 will be pending.

Claims 9, 16, 17, 20, 32, 52, 54, 55, and 77 are hereby cancelled, and claims 1, 6, 11, 31, 35, 38, 39, 43, 50, 58, 66, 70–73, and 78 are amended, and new claims 79–80 are added. Support for the claim amendments and new claims may be found, for example, in the Specification, page 5, line 30 – page 6, line 1; page 6, lines 30-32; page 7, line 30; page 8, lines 18-21; page 12, line 21 – page 13, line 30 including page 12, lines 26-27, page 13, lines 13-14 and lines 16-18, as well as in the originally filed claims.

Semihydrate of Calcium Sulfate

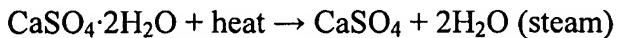
Independent claims 1, 31, 50, and 58 have been amended to recite semihydrate of calcium sulfate, i.e., $\text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O}$, rather than plaster. As indicated on page 6, lines 12–29 of the Specification, “plaster” may refer to a number of materials that include a substantial amount of $\text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O}$ (commonly referred to as semihydrate or hemihydrate of calcium sulfate) that is in powder form prior to application of an aqueous fluid. The claims were amended to clarify the scope of the invention, that includes material that is dry, but is also capable of rapidly setting upon application and absorption of a fluid. Thus, materials such as hydrated plaster as well as dead burned materials, i.e., materials that are already set or set very slowly, are explicitly excluded. Applicants note that, even though $\text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O}$ contains water, it is dry because the half-water molecule is bound into the plaster structure. Plaster literature typically distinguishes water that is “free,” i.e., not associated with the structure, from “water of hydration” that is bound into the crystal structure. An example of the latter type is the water molecule included in semihydrate of calcium sulfate, a dry material.

$\text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O}$ may be obtained from gypsum by a calcining reaction, as listed in the patent application. See Appendix 1, Kirk-Othmer Encyclopedia of Chemical Technology, exec. Ed. Jacqueline T. Kroschwitz; ed. Mary Howe-Grant, 4th edition, New York : Wiley, c1991-c1998, Vol. 7, pp. 961-965. This process takes place above 110 °C:



See Appendix 2, Anusavice, K.J., Phillips' Science of Dental Materials, 10th Edition, W.B. Saunders Company (1996), pp. 185–209. The first item is “gypsum” or “calcium sulfate di-hydrate”. This form is essentially inert, and barely soluble in water. It is the form often found in dietary supplements, cosmetics, foods, wall board, etc. The first term in the right-hand side of the equation is a preferred material for three-dimensional printing, as it is the form that reacts with water. See Appendix 3, Riddell, W.C., *Rock Products* (May 1950) pp. 58–71 and 102, and Appendix 4, Riddell, W.C., *Rock Products* (October 1954) pp. 109, 113, 117, for dicussion of solubilities of $\text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O}$ and CaSO_4 .

A side reaction to the calcining process may occur at temperatures over 170 °C, especially when the material is processed in low humidity environments:



The reaction product of this process equation (“ CaSO_4 ”) is called anhydrite, and typically dissolves much more slowly than either the dihydrate or semihydrate forms. See Riddell (1950). The difference in dissolution time has an impact on the rate at which the calcium sulfate is available to react and form the plaster structure of an article. Keene's cement (mentioned in the Riddell reference discussed below), also refered to as deadburned gypsum, is a blend of anhydrite with accelerators.

Telephone conference with Examiner

The undersigned thanks the Examiner for her time and courtesy in discussing a draft of this response during a telephone conference on April 16, 2007. The amendments and remarks herein incorporate suggestions made during the conference.

Rejections Under 35 U.S.C. § 112

Claims 1–4, 6–7, 9–24, 26–41, 43–55, 57–68, 70–74, and 76–78 are rejected under 35 U.S.C. § 112, first paragraph, as based on a disclosure which is not enabling. The rejection of claims 9, 16, 17, 30, 32, 54, 55, and 77 is moot in view of the cancellation of these claims. The other claims rejected under this section have been amended in response to the Examiner's objections regarding the requirement that the three dimensional printing composition must be

dry. Further, claim 31 (as well as independent claims 1, 50, and 58) has been amended to recite semihydrate of calcium sulfate.

Applicants submit that claims 1–4, 6–7, 10–15, 18–19, 21–24, 26–31, 33–41, 43–53, 55, 57–68, 70–74, 76, and 78 are enabled.

Claims 6 and 77 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite. Claim 6 has been amended to properly depend on claim 1, and claim 77 has been cancelled.

Applicants submit that amended claim 6 is definite.

Rejection of claims under 35 U.S.C. § 102

Claims 1–4, 6–7, 9–13, 22–24, 26–30, 32, 34, 37, 50–54, 59–65, and 78 are rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 3,303,147 to Elden (“Elden”) in view of evidence given in U.S. Patent No. 5,385,772 to Slovinsky (“Slovinsky”). Elden appears to disclose a dry powder composition including, e.g., 40–65% calcined gypsum, 4–10% polyvinyl acetate emulsifiable powder and polyvinyl alcohol powder, and 23–54% inert filler powder. *See* claim 1. A powder composition may also include an accelerator. *See* claim 8. The Examiner relies on Elden to disclose all of the elements of independent claims 1, 32, and 50.

The rejection of independent claim 32 is moot in view of the cancellation of that claim.

Elden does not teach or suggest a particulate material characterized by absence of a retardant, as recited in amended independent claims 1 and 50. Rather, Elden states that the compositions of the invention includes a retarder, explaining that:

Bone glue, or other equivalent animal glues, added primarily to function as a retarder for the setting of the plaster, also contributes binder properties, however, other known retarders for plaster, which would have no binder properties, may be substituted for the bond glue in accordance with the invention.

In the instant claims, the particulate composition does not include a retardant. Indeed, as stated in the Detailed Description,

[s]ince it is important in the present invention that the plaster set as quickly as possible, the addition of retardants should be avoided. Slowing down the rate at which the plaster

sets may allow too much of the aqueous fluid to migrate away, or the water to vaporize, before sufficient plaster and water have reacted.

See page 11, lines 6–9.

Applicants submit that for at least these reasons, amended independent claims 1 and 50 and claims dependent therefrom are patentable over the cited art.

Claims 1–4, 7, 9–14, 16–23, 26–30, 32–35, and 37 are rejected under 35 U.S.C. §102(b) as being anticipated by British Patent No. GB 2,155,944 (“the ‘944 patent”). The ‘944 patent appears to disclose powder compositions that include an inorganic filler, such as gypsum, 30–80% by weight. *See abstract, page 1, lines 17–18.*

The rejection of independent claim 32 is moot in view of the cancellation of that claim.

The ‘944 patent does not teach or suggest semihydrate of calcium sulfate, as recited in amended independent claim 1. Rather, gypsum, disclosed in the ‘944 patent, is an inert reaction product that is only used in a reacted state. Semihydrate of calcium sulfate, however, is a reactive material.

Applicants submit that for at least this reason, amended independent claim 1 and claims dependent therefrom are patentable over the cited art.

Rejection of Claims Under 35 U.S.C. § 103

Dependent claims 14, 15, 16–17, 18–19, 20, 21, 36, and 55 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Elden in view of the ‘944 patent, U.S. Patent No. 3,297,601 to Maynard (“Maynard”), U.S. Patent No. 4,042,408 to Murray et al. (“Murray”), the ‘944 patent, and U.S. Patent No. 3,835,074 to Desmarais (“Desmarais”). The rejection of claims 16–17, 20, and 55 is moot in view of the cancellation of those claims. None of the cited references, alone or in combination, provide what is missing in Elden, as discussed with reference to claim 1 above. Applicants submit that claims 14, 15, 18–19, 21, and 36 are patentable for at least the reasons claim 1, on which they depend, is patentable.

Independent claim 58 and dependent claim 57 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Elden in view of U.S. Patent No. 2,662,024 to Riddell (“Riddell”). The

examiner concedes that Elden does not teach dextrin as recited in independent claim 58, and relies on Riddell to provide this feature. Riddell appears to disclose cementitious compositions for use with gypsum wallboard including deadburned gypsum, i.e., Keene's cement. The Cementitious compositions may include from 15% to 20% dextrin to provide desired bulkiness. *See* column 1, lines 42–50 and column 2, lines 26 – column 3, line 2.

Neither Elden nor Riddell, alone or in combination, discloses a particulate mixture including semihydrate calcium sulfate in combination with an accelerator, the material characterized by the absence of a retardant, as recited in independent claim 58. As discussed above with respect to claim 1, the compositions disclosed by Elden are not substantially free of a retardant; indeed, Elden teaches against a composition not having a retarder, as recited in amended independent claim 58.

Moreover, one of skill in the art would not be motivated to combine the disclosure of Riddell with the composition taught by Elden. Riddell's composition includes deadburned gypsum, while Elden's compositions include the reactive composition of $\text{CaSO}_4 \frac{1}{2} \text{H}_2\text{O}$. These two materials have highly different properties in terms of the rate at which dissolve, and the use of dextrin with one of the materials, i.e., deadburned gypsum would not provide motivation for use of dextrin with the other, more reactive material, i.e., $\text{CaSO}_4 \frac{1}{2} \text{H}_2\text{O}$.

Applicants submit that for at least these reasons, amended independent claim 58 and claims dependent therefrom are patentable over the cited art.

Independent claim 39 and dependent claims 40–41 and 43 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Elden in view of U.S. Patent No. 3,309,328 to Carroll et al. (“Carroll”) and Slovinsky. Dependent claims 44–49 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Elden in view of Carroll and further in view of Maynard or Desmarais. Elden discloses a dry powder composition. *See* column 1, lines 10–13. The Examiner concedes that Elden does not disclose a printing aid, as recited in independent claim 39, and relies on Carroll to supply this feature. Carroll appears to disclose adhesive compositions for bonding of building materials. *See* column 1, lines 8–10. The compositions may include dispersing agents such as soya lecithin compound. *See* column 4, lines 1–6.

One of skill in the art would not be motivated to combine the dispersing agent that is included in a paste-like aqueous emulsion, i.e., in a liquid, as disclosed by Carroll with the dry powder disclosed by Elden. *See* Carroll, column 2, lines 3–9. One would not expect to obtain the same benefits from including a dispersing agent in a dry material as one might derive from including the dispersing agent in a liquid.

Applicants submit that for at least this reason, amended independent claim 39 and claims dependent therefrom are patentable over the cited art.

Independent claim 72 and dependent claims 73–74 and 76 are rejected as being unpatentable over U.S. Patent No. 3,852,083 to Yang (“Yang”) in view of Maynard. Yang appears to disclose fiber-containing plaster of Paris products that include latex. *See* column 1, lines 10–17. These products may include hydromodifiers such as polyvinyl alcohol. *See* column 8, lines 17–25. These products may also include mineral oil. *See* column 9, line 47. The Examiner recognizes that Yang does not disclose an accelerator, as recited in independent claim 72, and relies on U.S. Patent No. 3,297,601 to Maynard (“Maynard”) to provide this feature. Maynard appears to disclose a joint compound that may include plaster. *See* column 1, lines 10–22. The compound may include a set accelerator, e.g., potassium sulfate or terra alba. *See* column 4, lines 38–52.

Including an accelerator in the composition of Yang would render the product of Yang to be unsuitable for its intended purpose. Yang teaches against the use of an accelerator, stating that “[an accelerator] lead[s] to a product which sets too quickly to permit proper plastic forming.” *See* column 4, lines 57–61. Moreover, Yang products are plastic formed or extruded bodies, not dry, loose free-flowing powders, as recited amended independent claim 72.

Applicants submit that for at least these reasons, amended independent claim 72 and claims dependent therefrom are patentable over the cited art.